RECD

28 MAR 1977

MEMORANDUM FOR THE RECORD

SUBJECT: Effect of Project SAFE on the Headquarters Complex HVAC Systems

1. An analysis was made of the Headquarters Complex HVAC systems to determine the impact of Project SAFE on these systems. For the purposes of this analysis, the Headquarters Building air-conditioning load was obtained from the firm Vosbeck, Vosbeck, Kendrick, and Redinger (VVK&R) under the Phase II study. It was also assumed that all computer centers and supplemental air handlers are to be served by the Powerplant. A future load was calculated assuming that the final load in the SAFE area would be 150 percent of the initial 250 ton load and that the Office of Data Processing computer center located in Room 1D16 would be expanded to the outer building walls. (See attachment, page 1, for breakdown of above analysis).

2. The Headquarters Complex peak air-conditioning load with the addition of the Project SAFE computer center will be approximately 6,300 tons with a maximum future load of approximately 6,500 tons assuming the computer room expansions indicated above are accomplished. Five 1,500-ton chillers and one 1,000-ton chiller are presently located in the Powerplant providing a total chilling capacity of 8,500 tons. Thus, a minimum of 2,000 tons in excess chilling capacity presently exists in the Powerplant. It must also be pointed out that the 6,500 ton load is a peak load which would occur perhaps 10 percent of the hours in the summer months. With the computer centers on the Powerplant the normal operating load the majority of the time should be approximately 5,500 tons (4,300 tons Headquarters and P&P Building + 1,200 tons computer room). Operation of Carrier-Dunham/Bush chiller systems in the Headquarters Building would reduce the Powerplant loading by approximately 700 tons. However, even under the maximum load of 6,500 tons, sufficient chiller capacity exists in the Powerplant to provide a redundant capability.

3. The design specifications on the original four Powerplant cooling tower cells required each cell to have a 1,750 ton capacity at 80° F wet bulb (WB). The cooling tower cells reportedly did not provide the rated capacity and in the early 1970's the fill (heat transfer material) in each of the four cells was replaced and a fifth cell was added for redundancy. Each cell was to have a design capacity of 2,100 tons at 78° F WB. Tower Performance, Inc., performed the work which

was completed in 1972. Acceptance testing was performed on three of the original cells. The manufacturer indicated three capacity tests were run with the towers performing at 60 percent, 85 percent, and 92.8 percent of design capacity respectively. The manufacturer stated that the first two low capacity ratings resulted from improper cooling tower water maintenance and clogged spray nozzles. Prior to the final test the tower fill was shock treated with chemicals to remove slime and scale buildup and the spray nozzles were cleaned by the manufacturer. The results of this last test gave the towers a capacity rating of 92.8 percent and the towers were subsequently accepted by GSA with a $10,000 reduction in payment to the contractor.

4. Cooling tower capacity varies with the outdoor wet bulb temperature. The design wet bulb temperature of the new cells in 78° F which occurs approximately 90 hrs/yr. At an outdoor wet bulb temperature of 80° F which occurs approximately 24 hrs/yr, the cooling tower capacity would be reduced approximately 15 percent. As indicated on Table 1, page 4 of the attachment, four of the five cells would theoretically be sufficient to handle a 6,500-ton chilling load at 78° F WB. With the added load of the two-2000 kW generators, however, five cells would be required. At a 5,500-ton chilling load, four cells would theoretically be capable of handling the load even with the addition of the two-2000 kW generators. At an 80° WB temperature five cells would be required to handle the above loads, and a possibility exists that five cells would not be capable of handling a 6,500-ton chilling load with the generators.

5. The preceding theoretical analysis indicates that for all but a few hours each year under the most extreme loading conditions four of the five Powerplant cooling tower cells would be sufficent to handle the Headquarters Complex HVAC load. However, according to the Powerplant operating personnel, the actual capacity of each cell is much less than that indicated by the theoretical analysis. Powerplant personnel have indicated that during the preceding few summers a maximum of three-1500 ton chillers have been required to be operated. GSA has indicated that when the wet bulb temperature gets "too high", four and five cells are required to handle the three chillers. Use of four cells to handle a 4,500-ton chilling load would mean each cell would be operating at only 68 percent of the 1,850-ton capacity determined during acceptance testing. No specific information could be obtained as to what WB temperature was "too high", but it can be safely assumed from the duration of time four cells are required that the wet bulb temperature which is "too high" would be 80° F WB or less.

6. The manufacturer of the cooling tower stated that poor water treatment and maintenance were the causes of the low capacity results in the first two acceptance tests and further indicated that tower maintenance was not completely acceptable to them at the time of the third test. It is not known what the cooling tower water treatment was used in the years prior to

1976. However, in 1976 the cooling water treatment was changed by GSA and a chemist now tests the cooling tower water once a week and the tower is inspected once a year. The chemical now used, Calgon CL-70, is being added manually once a day and is used to control scale and corrosion. The GSA chemist indicated that no problems exist with the pH level of the water, biological growths, or deposition of silt on the tower fill material. GSA indicated the tower spray nozzles are not cleaned more than once a year.

7. In summation, it could not be determined at this time what problems if any, exist in the Powerplant cooling tower cells. Therefore, further survey work and study will be required this summer and all efforts in this regard will be coordinated with GSA. If the tower cells once performed at 1,850-tons, they should continue to do so unless inadequate maintenance is performed on them and improper cooling tower water treatment is provided. The chiller condenser tubes must also be considered; the condenser tubes are presently cleaned every 1 or 2 years.

8. The required chilled water flow rate for the 6,500-ton load would be 11,700 gal/min. There are presently five pumps at the Powerplant each rated at 2,690 gal/min at 240 ft. head pressure loss. An analysis of the existing piping system indicates each pump was overdesigned initially. Under the existing piping system configuration, the pressure losses at a flow rate of 11,700 gal/min total only 170 ft. head pressure loss. Therefore, each pump should be capable of providing a minimum of 3,000 gal/min under actual operating conditions. Thus, operation of four of the five Powerplant pumps will provide adequate chilled water flow to all parts of the Headquarters Building. In preceding years two pumps were required at all times to provide adequate chilled water flow to the Headquarters Building. It is felt this was due to improper balance of the chilled water system and the inoperative two-way chilled water control valves in the fan rooms. The chilled water flow to the air handlers was controlled manually and it is felt this resulted in massive short circuiting of the water through the basement fan rooms. The two-way control valves were repaired by GSA in the summer of 1976, and subsequent operation of one pump has been suffcient during winter operations. A further study of the pump/piping system operation will be made to determine the actual summer operation of the system. A rebalance of the Headquarters Building chilled water systems may be required to completely resolve this problem. The existing chilled water pipes are sized adequately such that the additional 1,100 gal/min flow rate under a projected future expanded load in SAFE of 480 tons (380 tons - computer center + 100 tons - UPS system) could be easily accommodated without resulting in excessive velocities or pressure drops in the piping system.

9. During a power outage the only areas requiring HVAC would be the computer centers and other selected areas within the Headquarters Complex. It is estimated these loads would not exceed 3,000 tons and this load could easily be handled by the existing Powerplant chillers, pumps, and cooling

tower cells. The control systems of each air handler in the Headquarters Building are such that when the fans are not in operation the chilled water coil valve is closed precluding any short circuiting problems. The secondary water control systems are currently operated in a manual mode. However, these controls will be upgraded under the VVK&R Task 4 design project and once this is accomplished, any potential short circuiting of water between the primary and secondary water systems should be eliminated.

10. Location of the SAFE area on the north side of the Headquarters Building would require a run of minimum 8-inch chilled water piping. The connection to the existing building chilled water piping would be made at the north basement at the running track or to the 14-inch riser to the North Penthouse Fan Room depending on the final location of the computer center.

11. Given the excess capacity which exists in the Powerplant, the need for additional supplemental chiller systems in the Headquarters Building must be questioned. With the addition of the second 2500 kW generator, two 1,500-ton chillers will be capable of being run during a power outage. This would adequately handle the computer centers including SAFE as the majority of the building fan rooms would also be out of operation. The major mechanical reliability factors, therefore, which would preclude use of the Powerplant, would be the chance of a rupture in the chilled water lines serving the building or a prolonged outage of the major equipment located in the Powerplant.

12. Considering the redundancy in the chillers, pumps, and cooling towers, failure of one of these pieces of equipment would not preclude adequate output from the Powerplant during a power outage. During normal operating times only the cooling tower capacity makes a redundant capability in the tower questionable. When the project to separate the cooling tower basin is complete, the annual cleaning of the cooling tower will not require a total chiller outage at the Powerplant.

13. A minor leak could occur in a main chilled water line in the Headquarters Building. However, for small leaks this presents no major problem. Collars are made commercially or can be fabricated by GSA to seal small leaks. Collars are also available to seal leaks in flanges. The GSA plumbing foreman has indicated collars such as these should hold, and have held, for as long as 1 year or more. A separate 8-inch chilled water line could be run from where the 24-inch chilled water lines enter the building to the SAFE area. However, this would cost an additional $80,000 and this extensive redundancy is not felt to be needed.

14. More serious considerations are potential leaks and deterioration of the underground chilled water lines between the Powerplant and the Headquarters Building. A recent study conducted by GSA indicated these

SUBJECT: Effect of Project SAFE on the Headquarters Complex HVAC Systems Con't

lines do not presently have a properly functioning cathodic protection system. It is difficult to determine how long these lines have been without adequate protection or to what extent these pipes have deteriorated. The possibility of a leak developing in the chilled water lines is a probable occurrence, and, since the lines are buried underground, location and repair of a serious leak could result in an extended outage. Construction of a parallel set of chilled water lines between the Powerplant and the Headquarters Building and installation of a properly working cathodic protection system on the existing chilled water lines would resolve the unreliability inherent in having only one set of chilled water lines.

15. The alternative to use of the Powerplant is the installation of additional supplemental chiller systems to serve the new computer center. Location of supplemental chillers for SAFE in the north half of the building would be difficult due to space considerations. Initially two 125-ton chillers would be required. Total installation cost would be approximately $150,000. Total space requirements to install two 125-ton chillers with accompanying electrical and pumps would be at a minimum 800 square feet. The only available space in the north basement to install supplemental chillers would be room BF14. However, to make this space available the GSA control shop and IBM technician shop would have to be relocated. Possibly a section of the gymnasium would be required should space requirements increase during the final design. Future addition of another 125-ton chiller would require an additional 200 square feet of floor space and $80,000 in funds. Use of the existing conveyor tunnel for the chillers would be precluded due to the difficulty in placing the equipment in the tunnel.

16. With the installation of supplemental chillers in room BF14, air-cooled condensers would be required in the north courtyard. This is due to the anticipated aesthetic unacceptability of locating a condenser or cooling tower on the first floor roof or a cooling tower in the north courtyard. Two new 125-ton condensers would require an area of approximately the same size as the existing areaway. However, unlike the design of the Carrier system, the use of building relief air would not be feasible, as under the new VVK&R project upgrading the air handler outside air dampers total relief air during the summer months from the North Basement Fan Room would be only about 15 percent of the total air required by the condensers. In addition during a power outage few of the fans in the North Basement fan room may be operational. Therefore, the condensers would have to be located on top of the areaway to allow for free airflow from the courtyard or adjacent to the areaway on separate pads. There would be some problem moving the condensers into the courtyard, but this could be accomplished and through the use of shrubbery, etc., the installation could be made to blend in somewhat with the courtyard environment.

17. Another alternative for a supplemental system would be the rehabilitation of the existing 300-ton Worthington chiller located in the Kitchen Fan Room. Discussions with Worthington indicate that rehabilitation of the chiller is a reasonable alternative. However, a preliminary teardown inspection by Worthington, costing approximately $2,000, would be required to determine the work required in rehabilitating the machine. Very rough estimates by Worthington indicate the cost could run between $11,000 and $30,000. Use of this chiller as a standby unit would require an additional 800 ft. run of 8-inch chilled water piping and more significantly would require installation of new towers for the Acme chillers which serve the Communications Center in room 1B27. Assuming the above were accomplished, some question exists as to whether the existing chiller system would work properly. When this equipment was installed, the Chief GSA Operating Engineer in the Headquarters Building indicated that when the chiller was tested the existing cooling towers were not capable of providing rated capacity. Given the above circumstances, this alternative is not recommended. Removal of the existing chiller and use of that space to install new units would seem to be unfeasible due to the difficulty in moving large pieces of equipment into or out of the area.

18. Another alternative for additional space to locate supplemental chillers would be the excavation of 2,000 square feet of presently unexcavated space in the basement between room BF14 and the pneumatic tube shop. Admittedly, this would be an extremely expensive venture and would have to be carefully analyzed but would provide additional usable space in the basement. Overall, however, the most practical location for supplemental chillers to serve the SAFE computer center would be in room BF14 and location of air-cooled condensers in the north courtyard.

19. From the standpoint of system capacity, the Powerplant could be used to supply chilled water to the new SAFE area and all computer centers in the Headquarters Building in lieu of additional supplemental systems. Powerplant operation would be a reliable mode of operation once a parallel set of chilled water lines is installed between the Powerplant and Headquarters Building and the cooling tower problem is solved because of the redundancy of the major components which would then exist. Intrinsic in a discussion of reliability is the question of proper maintenance for all pieces of equipment. While adequate preventive maintenance on the part of GSA has been lacking, this aspect must be a prominent factor in any decision to use the Powerplant as the prime supplier of chilled water for the Headquarters Complex.

SIGNED

STATINTL

Project Engineer
Headquarters Engineering Branch, RECD/OL

Next 4 Page(s) In Document Exempt